Europace (2005) **7**, 428–432

ELSEVIER

EUROPEAN SOCIETY OF CARDIOLOGY®

SHORT SERIES REPORT

Coronary sinus mapping to differentiate left versus right ventricular outflow tract tachycardias

Arash Arya*, Majid Haghjoo, Zahra Emkanjoo, Mohammad Ali Sadr-Ameli

Department of Pacemaker and Electrophysiology, Rajaie Cardiovascular Medical Center, Mellat Park, Vali-Asr Avenue, Tehran 1996911151, Iran

Submitted 14 September 2004, and accepted after revision 17 March 2005

KEYWORDS
ventricular tachycardia;
catheter ablation;
coronary sinus;
mapping

Abstract Outflow tract ventricular tachycardia (OT-VT) can originate from several different segments of the outflow tract. Various ECG criteria have been proposed for localization of OT-VTs. We present two patients, one with left and one with right OT-VT. We used local ventricular electrograms in the coronary sinus to localize the focus of the OT-VT. Mapping of local ventricular electrograms in the coronary sinus may be a simple and effective method for differentiating right versus left ventricular outflow tract tachycardias. However, the diagnostic value and precision of this method should be evaluated in a series of patients before its implementation in the OT-VT ablation decision algorithm.

Introduction

Outflow tract ventricular tachycardias (OT-VTs) can originate from several different segments of ventricular outflow [1–6], including the left ventricular outflow tract (LVOT), which was originally described nearly 8 years ago [2]. Often the QRS morphology of the VT is the first clue to the site of successful ablation. There have been several reports on the application of 12-lead ECG findings for localization of OT-VT [4–7]. Ito et al. recently developed an ECG algorithm for anatomical localization of the site of origin of OT-VTs [8]. We hereby present a simple method for discrimination of left versus right OT-VTs by intra-CS mapping of local ventricular electrograms (LVE).

* Corresponding author. Tel.: +98 912 126 1467; fax: +98 21 878 4618.
E-mail address: arya@rhc.ac.ir (A. Arya).

1099-5129/$30
doi:10.1016/j.eupc.2005.03.011

Case report

Case 1

A 30-year-old male patient was referred to our centre for evaluation of frequent episodes of palpitation and wide complex tachycardia. He had no structural heart disease. His previous medical records revealed several ECGs during arrhythmia all showing regular wide complex tachycardia with right bundle branch block morphology (Fig. 1A).

An electrophysiological study, followed by radiofrequency catheter ablation (RFCA), was performed. Three 6F quadripolar catheters (DAIG®, St. Jude Medical Inc., USA) were introduced via left femoral vein and positioned at right ventricular (RV) apex, His bundle and high right atrium, respectively. A Wide QRS complex and haemodynamically stable tachycardia with a cycle length of 490 ms was induced reproducibly by incremental RV pacing (Fig. 1A). Based on the ECG algorithm proposed by Ito and his colleagues [8], this arrhythmia was compatible with left OT-VT. As the accuracy of this algorithm is not 100%, we first started the arrhythmia activation mapping from the right ventricular outflow tract (RVOT). After extensive mapping during the arrhythmia, the earliest LVE, compared with the onset of the QRS complex, in RVOT was −12 ms. Unipolar pace mapping at this point was not ideal with incomplete matching.

A 7F steerable decapolar (2-2-2 mm, Marinr®, Medtronic Inc, USA) catheter was introduced via the right femoral vein to the CS (Fig. 2A and B). Under fluoroscopic guidance in both right and left anterior oblique views, the catheter was passed well into the great cardiac vein (GCV). As the catheter entered the GCV it left the AV groove, and in this way its position could be verified during fluoroscopy. We then withdrew the catheter gradually until the distal dipole lay just at the orifice of the GCV, in AV groove (point B). At this position, the proximal dipoles of a decapolar catheter with

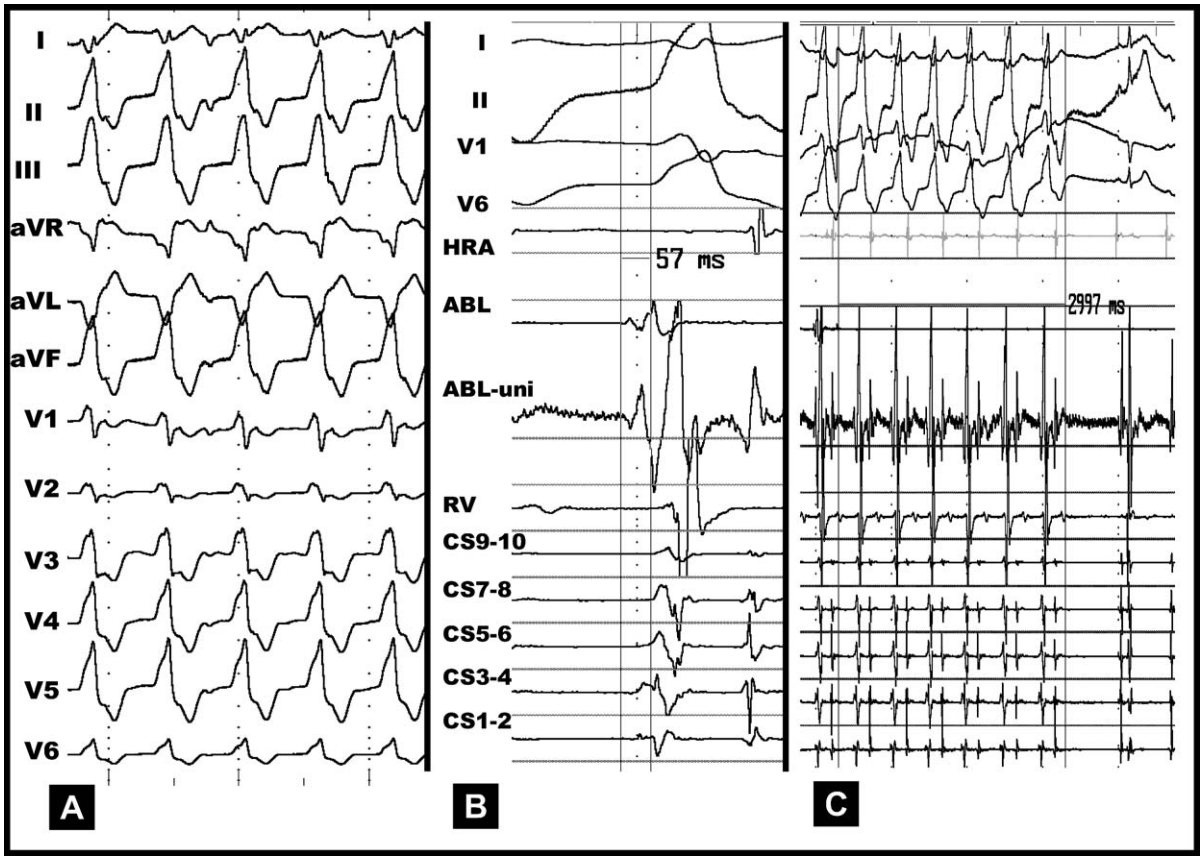

Figure 1 (A) Twelve lead ECG of tachycardia. (B) Intracardiac recordings at the successful site of RF ablation. Note that the earliest coronary sinus ventricular electrogram is recorded at the distal pole which is located at point A (Fig. 2). (C) Arrhythmia terminated 3 s after RF application. HRA: high right atrium, ABL: ablation catheter, ABL-uni: unipolar recording from distal electrode of ablation catheter, RV: right ventricle, and CS: coronary sinus.

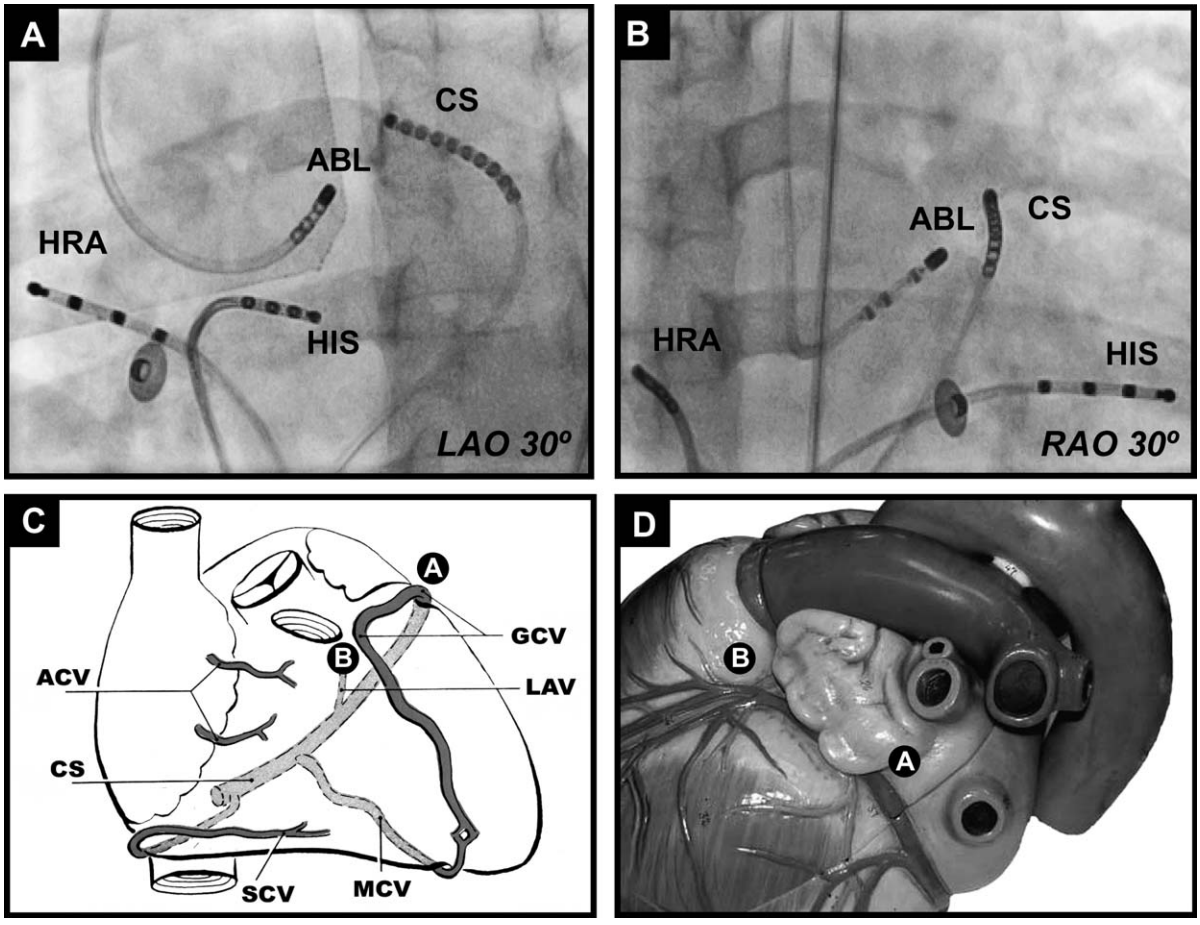

Figure 2 (A and B) Fluoroscopic view of intracardiac catheters at successful RF ablation site in the left (LAO) and right (RAO) anterior oblique views, respectively. (C and D) Schematic drawing and photograph of CS course, respectively. Note that points A (distal CS) and B (GCV) are closer to the LVOT and RVOT, respectively. HRA: high right atrium, CS: coronary sinus, RVA: right ventricular apex, ABL: ablation catheter, GCV: great cardiac vein, LAV: left atrial vein, MCV: middle cardiac vein, SCV: small cardiac vein, ACV: anterior cardiac vein.

2-2-2 configuration will be in point A (near the left atrial appendage) as depicted in Fig. 2C and D [9]. As an alternative after delineating the position of point B with the above method, we can, under fluoroscopic guidance, withdraw the distal electrode from point B to point A for mapping as shown in Figs. 1B and 2A,B. This point would be closer to the LVOT than the RVOT. LVE at the distal CS electrodes at point A were −33 ms earlier than QRS onset (Fig. 1B). Based on this finding we confirmed that the site of origin of this OT-VT is located in LVOT. A 7F ablation catheter (4 mm tip, Conductr®, Medtronic Inc, USA) was introduced via the right femoral artery and positioned via the aortic valve in the LVOT for mapping and subsequent RF ablation. Activation mapping during arrhythmia in LVOT (guided by the position of CS catheter) revealed a point with the earliest LVE, −57 ms earlier than surface QRS complex (Fig. 1B). A single radiofrequency (RF) energy application (50 W, 70 °C, for 60 s) at this site was successful in termination and prevention of induction of LVOT tachycardia (Fig. 1C). During a follow up period of 6 months the patient has remained free of symptoms and arrhythmia.

Case 2

To assess further the discriminative value of intra-CS mapping during OT-VT, we performed the same approach as described above in a 35-year-old female patient who underwent electrophysiological study and RF ablation at our department for a wide complex tachycardia compatible with right OT-VT (Fig. 3A). She had no structural heart disease. CS mapping showed that the earliest LVE was recorded in CS1−2, located at the beginning of the GCV (Fig. 3B). Mapping and ablation of right OT-VT was then guided mainly by activation mapping

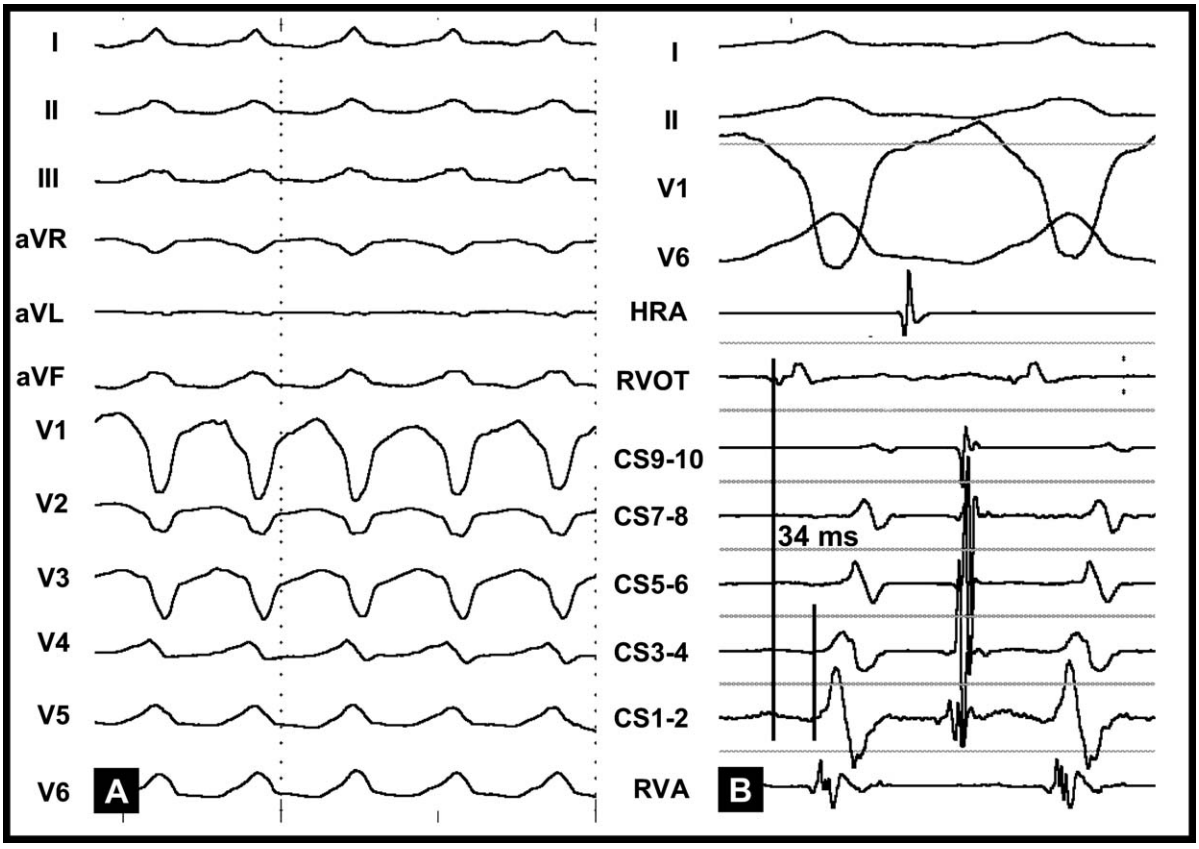

Figure 3 (A) Twelve lead ECG of tachycardia. (B) Intracardiac recordings during tachycardia. Note that the earliest ventricular electrogram is recorded on RVOT catheter which is −34 ms earlier than the distal CS (point B in Fig. 2). HRA: high right atrium, CS: coronary sinus, RVA: right ventricular apex, RVOT: right ventricular outflow tract.

during tachycardia, with confirmation of pace mapping finding the best 12-lead pace-map match to the clinical tachycardia before ablation. RF energy application (50 W, 60 °C, for 60 s) at this site was successful at termination and prevention of induction of right OT-VT tachycardia.

Discussion

OT-VT is defined as VT arising from different segments of the outflow tracts in a patient with a structurally normal heart. As OT-VTs are usually haemodynamically stable and focal in origin, ablation of OT-VT has been highly successful. Accurate localization of OT-VT focus is an important determinant of successful RF ablation, however the site of origin (left versus right) of OT-VTs is not always easy to identify [7]. Different ECG criteria have been proposed for localization of OT-VTs [4—8].

We hypothesized that LVE in the CS may be useful for localization of OT-VTs. As the CS continues its course in the left atrioventricular groove, it turns around the lateral border of the left ventricle and approaches the left atrial appendage. At this point in the distal CS (point A in Fig. 2C and D, see above for suggested method of CS catheter positioning) it is anatomically closer to the LVOT than the RVOT. In contrast, the GCV has closer anatomical proximity to the RVOT in the anterior interventricular septum (point B in Fig. 2C and D). So, in cases of left OT-VT earliest LVE is expected to be recorded near point A compared with the beginning of the GCV (point B). In right OT-VT the opposite is expected. In our case mapping during arrhythmia (guided by the position of CS catheter) localized the site of origin to the endocardial aspect of LVOT (Fig. 2A and B) which was subsequently ablated.

The findings of CS mapping in a case of right OT-VT are shown in Fig. 3. Contrary to our left OT-VT case, activation mapping in the CS localized the earliest LVE to CS1—2 which was located at the beginning of GCV (see above). Further mapping localized the earliest LVE in RVOT which was −34 ms earlier than LVE in CS1—2. These results

suggest that CS recording could be a simple method to differentiate left from right OT-VT. However, the diagnostic value and precision of this method should be evaluated in a series of patients before its implementation in the OT-VT ablation.

To the best of our knowledge this is the first report on potential application of intra-CS mapping for differentiation of right versus left OT-VT. Earliest local ventricular activation in the coronary sinus could be recorded in patients with right OT-VT if the recording dipole is placed very distal and close to the GCV.

In conclusion mapping inside the coronary sinus not only may help to differentiate epicardial versus endocardial sites of origin of left OT-VTs, but also may be a simple and effective approach to differentiation of right versus left OT-VTs. In cases of left and right OT-VTs, earliest LVE in CS is expected to be recorded in the distal CS (point A) and beginning of the GCV (point B) (Fig. 2C and D), respectively. Further studies on a series of patients with OT-VT are warranted to validate the efficacy of this method for accurate localization of OT-VT, before implementing it in the OT-VT ablation decision tree.

Acknowledgement

The authors wish to thank Elham Hasheminejad, M.D. for reviewing the manuscript.

References

[1] Lerman BB. Ablating left ventricular outflow tract tachycardia: in search of Ockham's razor. Pacing Clin Electrophysiol 2004;27:1051—2.
[2] Callans DJ, Menz V, Schwartzman D, Gottlieb CD, Marchlinski FE. Repetitive monomorphic tachycardia from the left ventricular outflow tract. Electrocardiographic patterns consistent with a left ventricular site of origin. J Am Coll Cardiol 1997;29:1023—7.
[3] Yeh S, Wen M, Wang C, Lin F, Wu D. Adenosine-sensitive ventricular tachycardia from the anterobasal left ventricle. J Am Coll Cardiol 1997;30:1339—45.
[4] Hachiya H, Aonuma K, Yamauchi Y, Harada T, Igawa M, Nogami A, et al. Electrocardiographic characteristics of left ventricular outflow tract tachycardia. Pacing Clin Electrophysiol 2000;23:1930—4.
[5] Ouyang F, Fotuhi P, Ho SY, Hebe J, Volkmer M, Goya M, et al. Repetitive monomorphic ventricular tachycardia originating from the aortic sinus cusp: electrocardiographic characterization for guiding catheter ablation. J Am Coll Cardiol 2002;39:500—8.
[6] Hachiya H, Aonuma K, Yamauchi Y, Igawa M, Nogami A, Iesaka Y. How to diagnose, locate, and ablate coronary cusp ventricular tachycardia. J Cardiovasc Electrophysiol 2002; 13:551—6.
[7] Miles WM. Idiopathic ventricular outflow tract tachycardia: where does it originate? J Cardiovasc Electrophysiol 2001; 12:536—7.
[8] Ito S, Tada H, Naito S, Kurosaki K, Ueda M, Hoshizaki H, et al. Development and validation of an ECG algorithm for identifying the optimal ablation site for idiopathic ventricular outflow tract tachycardia. J Cardiovasc Electrophysiol 2003;14:1280—6.
[9] Ortale JR, Gabriel EA, Iost C, Marquez CQ. The anatomy of the coronary sinus and its tributaries. Surg Radiol Anat 2001; 23:15—21.